Pilot freeze drying systems
Innovative technology

High performance and
high efficiency

www.martinchrist.de


EPSILON 2-4 LSCplus

Successful from proof of principle

to production

Martin Christ Gefriertrocknungsanlagen is a worldwide leader in the development and manufacture of freeze dryers, with over 70 years of experience.

Now we would like to present what may be the most innovative area of endeavour within our company: manufacturing freeze dryers for process development and small-batch production – our pilot freeze drying systems.

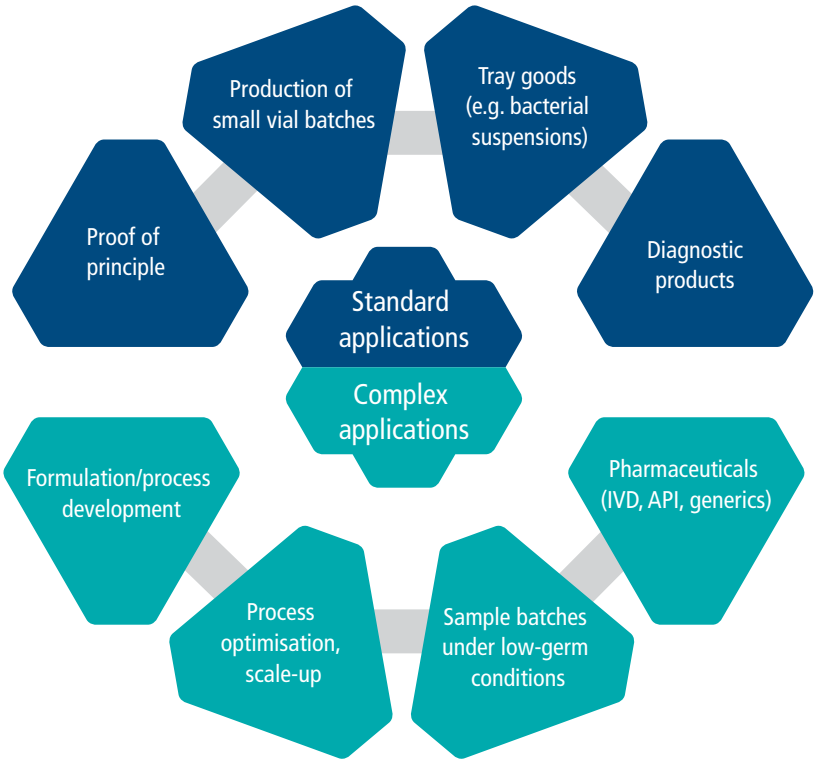
Here as well, the name Martin Christ stands for the highest level of customer satisfaction around the world. We develop and build according to the highest standard of quality to provide superior customer benefits. Our corporate strategy is focussed on your applications.

We see ourselves as a global innovation leader. We are continuously solidifying our outstanding position in the field of freeze drying with technological innovations, such as WTMplus 2.0 wireless product temperature measurement, LyoCoN (controlled nucleation) for crystallization at the push of a button, and LyoCam for process-integrated camera monitoring. Dozens of corporate patents are undeniable proof of our pioneering approach.

Pilot freeze dryers from Martin Christ are ideally suited to research & development. They are also the perfect choice for small-batch series production. Users can choose from various models. Each of them delivers optimal results in the freeze drying of solids or liquids in a wide variety of containers. With similar geometries, comparable temperature control systems and identical user interfaces, these systems follow the same philosophy as our large production units.

Detailed but nevertheless intuitive process control is as much a matter of course for all models as the use of the best available process analytical technologies (PAT tools), which are particularly important for development tasks.

We are at home in virtually all industries, with a strong focus on the pharmaceutical and biotech segments.



Optimal equipment

for R&D and small-batch series production

The Epsilon 1-4 LSCplus and Epsilon 2-4 LSCplus freeze dryers are the best choice for routine tasks. The single-chamber system has a 4 kg ice condenser integrated in the product chamber. The large shelf is cooled directly by the refrigerant, resulting in a low shelf temperature as well as cooling and heating rates that are nearly twice as fast as indirectly cooled shelves.

Epsilon 1-4 LSCplus

Epsilon 2-4 LSCplus

4 kg | –55°C / –88°C | ~ 430 x 2 ml / ~ 30 x 100 ml

Equipped with stainless steel shelves with a synthetic heat transfer fluid, the larger Epsilon 2-6D LSCplus and Epsilon 2-10D LSCplus systems meet the highest standards of the pharmaceutical and biotech industries.

The integrated intermediate valve separates the specimen chamber from the ice condenser chamber. These double-chamber systems with a separate ice condenser integrate even more PAT functions for process optimization and development.

Epsilon 2-6D LSCplus

6 kg | –85°C | ~ 840 x 2 ml / ~ 42 x 100 ml

Epsilon 2-10D LSCplus

10 kg | –85°C | ~ 3,065 x 2 ml / ~ 98 x 100 ml

Second to none

High-performance pilot systems with large ice capacity

Epsilon 2-12D LSCplus

12 kg –78°C ~ 4,100 x 2 ml ~ 180 x 100 ml

With an ice capacity of 12 kg or 16 kg, the pilot freeze dryers are comparable to larger production units. The refrigeration system is water cooled with generously sized compressors.

The Epsilon 2-12D model with LSCplus, or with a Siemens controller, is often used for recipe development and for scaling up with a maximum number of PAT tools. This freeze dryer is optimally suited to process development.

Optional features of the Epsilon 2-12D:

- CIP-capable
- In-wall installation

Epsilon 2-16D LSCplus

16 kg –78°C ~ 10 x 1.2 l bulk

The Epsilon 2-16D offers up to 1.2 m² of shelf area. It is specifically designed for 24/7 production of tray goods (bulk), such as pharmaceutical raw materials or bacterial suspensions, as well as special formats such as MTPs or tall containers that do not require sealing.

Especially suited to development in the pharmaceutical sector

A broad palette of individual solutions

For unlimited functionality

Design features

We offer the utmost in functionality and design features for successful research and process development.

- Shelf temperature control
  High performance with active cooling and heating at rates of more than 2 K/min, depending on the model.
- Sealing device for vials – manual or automatic
- Process control – without compromise
  Intuitive LSCplus user interface, can be combined with LPCplus process visualisation
- Hot gas defrosting
- System qualification

Setting the standard for high-quality, efficient systems

Special solutions – custom solutions

We adapt the configurations to the requirements of our customers.

- Cleanroom integration
- Integration with a containment system
- H_2O_2 decontamination with validation
- Single-plate sealing for phased sealing of vials, depending on model
- Adjustable ice condenser temperature, depending on model

Example:
Integration with a glove box

The new Standard 2.0

Pilot freeze dryers

The new standard design of our popular pilot freeze dryers in the Epsilon 1-4 LSCplus, Epsilon 2-4 LSCplus, Epsilon 2-6D LSCplus and Epsilon 2-10D LSCplus series includes smart, innovative PAT tools for process optimization. The available packages provide optimal solutions for both product development and small-batch series production.

Depending on the specific freeze dryer, the following PAT tools can be selected as standard options:

- LyoCam 2.0 – innovative camera system
- WTMplus 2.0 – wireless temperature measurement
- RFID reader – very simple identification of temperature sensors
- LyoCoN – controlled freezing of all vials
- MTMplus – temperature measurement across all vials
- Comparative pressure measurement – detection of the end of the main drying phase
- LyoBalance – balance system
- LPC plus – process visualisation

The base units are also equipped for the retrofitting of additional options, making them future-proof in terms of extensions.

Modular structure for short delivery times and easy retrofitting

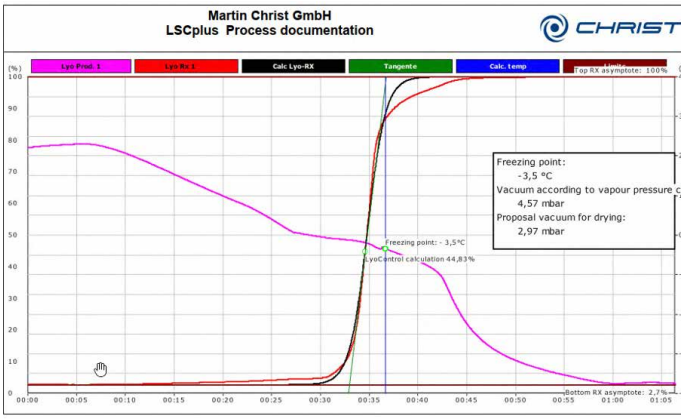
Smart solutions for optimal process observation

PAT tools

LyoControl – freezing point determination

The LyoRx sensor monitors the electrical resistance and product temperature. From the curves of both of these variables, you can automatically determine the freezing point of your product. Our LyoLogplus software with LyoControl makes this possible.

The LyoRx sensor allows automated control of the energy supply to the shelves during the main drying phase, so you can avoid critical temperatures during the main drying phase. This reduces the risk of defrosting effects on the product.



LyoCam 2.0 – camera system

Video recordings of the product at variable intervals, depending on the process steps or as event-driven recording. LyoCam enhances the transparency of the freeze drying process. Freeze drying monitoring and analysis are easy and uncomplicated with this technology from Martin Christ.

- High-end full HD industrial camera
- Cold-light LED lamps to avoid energy input
- Fully integrated in LPCplus process visualisation
- Smart image storage with frame rate linked to specific process results

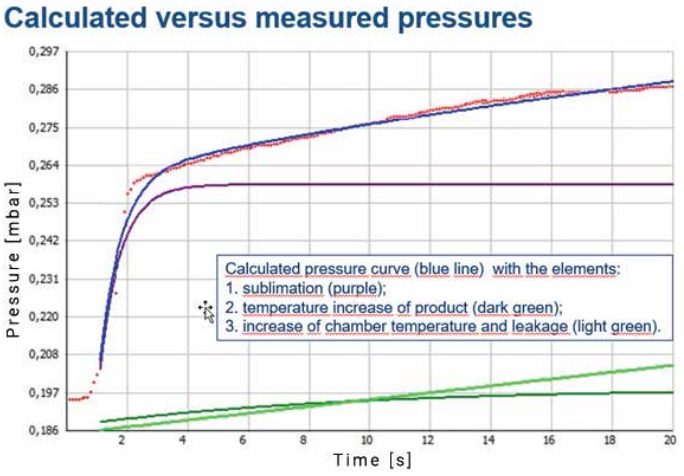
Well-conceived, fully integrated tools

PAT tools

MTMplus – manometric temperature measurement method

The product temperature is one of the critical parameters in freeze drying. It influences the form of the ice structure and the speed of the freeze drying process, and it can initiate a thawing process. Optimal temperature monitoring is possible with the MTMplus dynamic manometric temperature measurement system optimized by Martin Christ.

- The product temperature is calculated online during the measurement process.
- Non-invasive method for determining the product temperature
- Reduced risk of product damage
- Easily retrofitted in many Christ freeze dryers



WTMplus 2.0 – wireless temperature measurement

The WTMplus 2.0 wireless temperature measurement system from Martin Christ enables wireless product temperature measurement for freeze drying. The wireless sensors are placed directly in the vials and report the product temperature to the system controller during the entire drying process.

- Battery-free passive design for low influence on product temperature
- Temperature sensors powered by an interference-free radio signal
- Sensor positions can be documented with LPCplus
- Up to 16 sensors at various positions for process monitoring
- Guaranteed service life of 100 cycles for the entire sensor
- GMP design of antennas and sensors
- Easy sensor identification with RFID reader

Smart solutions for optimal process observation

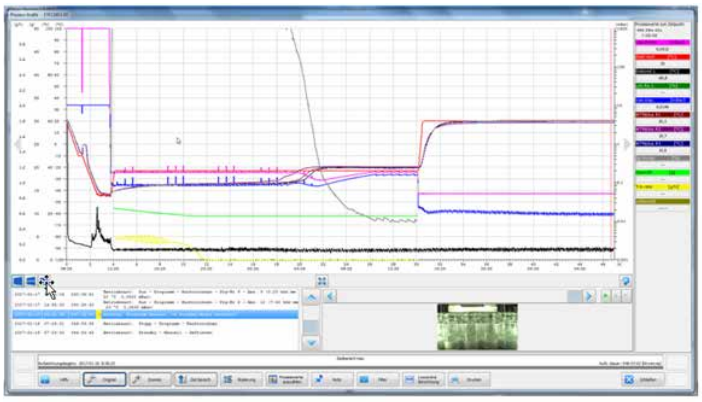
PAT tools

Pressure rise test

The transition between main drying and final drying can be determined using the pressure rise test. This is done by briefly closing the valve between the product chamber and the ice condenser. If the pressure rise in the product chamber with the intermediate valve closed remains below a defined limit, moisture is no longer sublimating from the product and final drying can be started automatically.

Comparative pressure measurement

The end of the main drying phase can be detected by using two different vacuum measurement sensors (Pirani gauge and capacitive sensor). When the difference between the pressure measurements falls below a preselected threshold, final drying is started automatically.



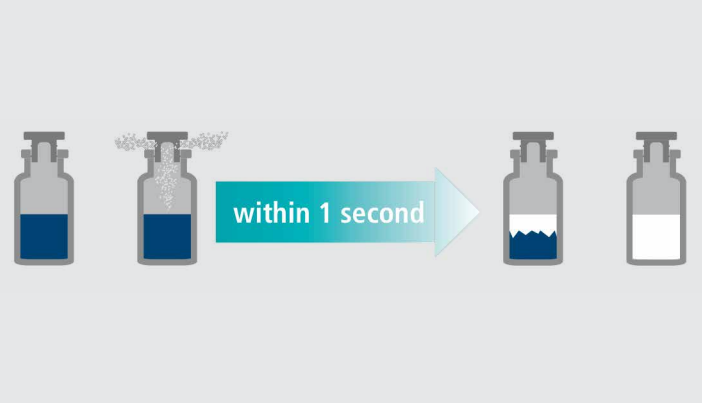
Fully integrated tools

PAT tools

LyoCoN – controlled nucleation

The LyoCoN controlled freezing function from Martin Christ ensures the simultaneous freezing of all vials. The crystallization of all vials in the freeze dryer is initiated at the press of a button.

- The ice fog is generated directly by the product, eliminating the need for additional external substances.
- GMP compliant method
- No release of gas (with potential product content) from the chamber
- Can be deployed in almost pilot systems



LyoBalance – precise drying rate determination

LyoBalance provides the ultimate direct measurement of drying progress. A truly innovative feature is operational integration in the LSCplus system controller, with data monitoring by the LyoLogplus or LPCplus software.

This means that no additional software is required for recording the weight loss. The drying rate (g/h) is also documented. Users can directly evaluate comparative tests, enabling cycle optimization on a sound basis.

- End of drying determined from weight loss
- Fully integrated in the system controller and the documentation software

Convenient and intuitive

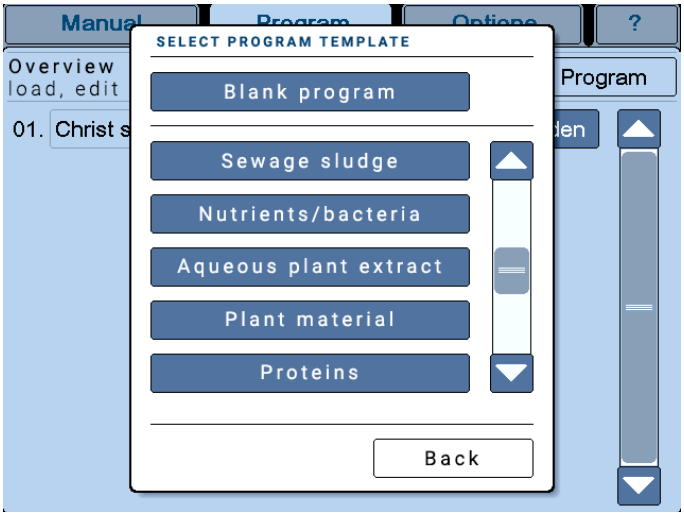
LSCplus system controller

LSCplus:
Unique system controller
Convenient and intuitive

Future-oriented technologies are brought together in the LSCplus system controller to make an easy-to-use, intuitive user interface. All of the accessories are also integrated.
Reproducible results are assured by automatic process sequences.

- Colour touchscreen with clear presentation
- Automated or manual sequencing of freeze drying processes
- Intuitive program entry using various freeze drying sequences or recipes
- Capacity for 32 user-defined programs
- Graphical display of freeze drying sequence (set values)
- Choice of several continuation conditions, depending on the system configuration
- Extensive message texts and explanations
- Multiple language options
- Selectable units for temperature (°C, °F) and pressure (mbar, hPa, Torr)
- Optional password protection
- Process data acquisition and optional data exchange over USB or Ethernet

LSCplus colour touchscreen



Sample programs for a wide range of applications

Processes monitoring

For precise documentation and evaluation

Our experience shows: processes must be precisely monitored and documented. This is the only way to achieve accurate analysis of a wide range of applications – regardless of the drying recipe and batch size.

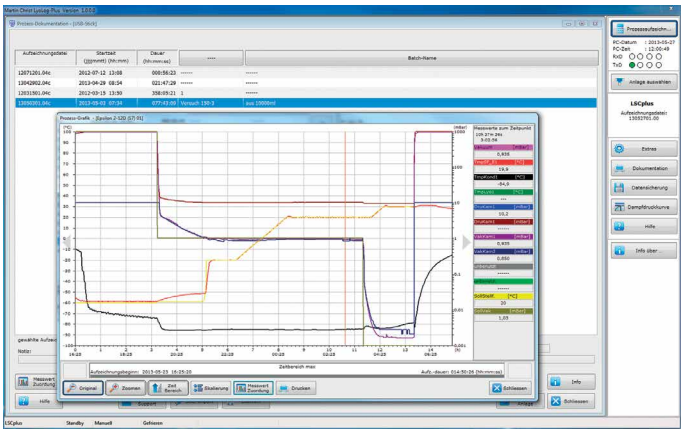
Documentation and archiving of all process data is possible with the LyoLogplus software, which can be installed on a separate PC. Data can be transferred from the freeze drying system to the PC via USB storage media or directly over Ethernet. LyoLogplus enables seamless documentation and post-process analysis with an intuitive user interface.

You can also use LPCplus process visualization. With LPCplus, programs for freeze drying can be developed and process data can be viewed in real time in graphical format. Operation is consistent and uniform across all unit sizes, as LPCplus is also used with larger production freeze drying systems.

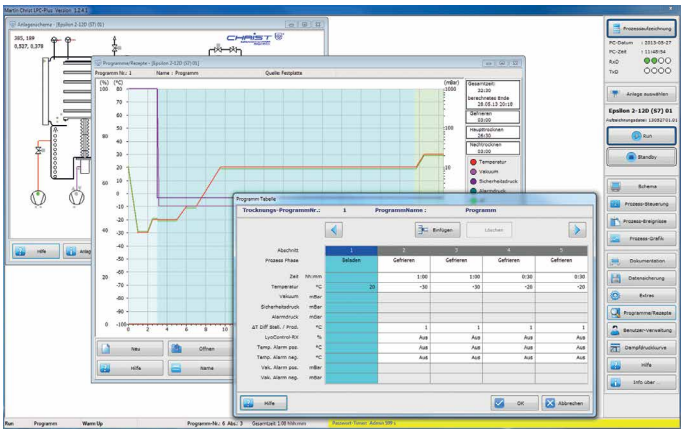
Are you planning to scale up?
Take advantage of easy platform migration from pilot scale to production scale with a uniform user interface and the same software solutions.

- Data recording on USB medium
- Simple process documentation with LyoLogplus
- LPCplus for process control and documentation
- Process monitoring with the LyoRx sensor to avoid undesired defrosting effects
- Automatic freezing point determination with LyoControl for reliable process control
- Wireless product temperature measurement WTMplus 2.0 for easy operation with improved sensor technology
- LyoLogplus and LPCplus with multilingual interface

The system concept of our freeze drying systems is based on the cGMP/GLP guidelines. The LPCplus software conforms to the current GAMP guidelines.



LyoLogplus software for process documentation



LPCplus software for process control and documentation

View the LPCplus video.
Link:
www.martinchrist.de/LPCplus

Technical data

Specifications	Epsilon 1-4 LSCplus	Epsilon 2-4 LSCplus
Ice condenser:	Single-chamber system	Single-chamber system
• Max. capacity	4 kg	4 kg
• Performance	3 kg/24 h	3 kg/24 h
• Temperature (approx.)	–55°C	–85°C
• Chamber volume (approx.)	41 l	41 l
Shelf system:		
• Dimensions (W x D)	270 x 400 mm	270 x 400 mm
• Temperature range (approx.)	–45°C to +60°C	–70°C to +60°C
• Temperature accuracy	<±2 K	<±2 K
• Cooling rate (+20°C to –40°C)	2 K/min	2.3 K/min
Dimensions (W x H x D) with sealing device (mm)	780 x 975 x 550	780 x 975 x 550
Weight (approx.)	110 kg	140 kg
Electrical connection (other voltages available upon request)	230 V / 50 Hz 230 V / 60 Hz 208 V / 60 Hz	230 V / 50 Hz 230 V / 60 Hz 208 V / 60 Hz
Water cooling	○	○
Noise level as per DIN 46535 (approx.)	54 dB(A)	51 dB(A)
Defrosting	Hot gas	Hot gas
Vial closure		
• Manual	●	●
• Hydraulic	○	○
• Automatic function "venting-sealing-storage"	○	○
Process control and PAT tools:		
Safety functions		
• Safety pressure	●	●
• LyoRx monitoring to prevent defrosting	●	●
PAT tools:		
• MTMplus	–	–
• LyoCoN	–	–
• WTMplus 2.0 with RFID	○	○
• LyoBalance	○	○
• LyoCam 2.0	○	○
• LyoControl	●	●
• Comparative pressure measurement	○	○
• Pressure rise test	–	–
Communication		
• Programming module for up to 32 recipes	●	●
• Ethernet interface	●	●
• USB	○	○
• LyoLogplus software for process documentation	○	○
• LPCplus software for process control and documentation	○	○

● = Standard ○ = Option – = Not available

Subject to change without prior notice.

	Epsilon 2-6D LSCplus	Epsilon 2-10D LSCplus	Epsilon 2-12D LSCplus	Epsilon 2-16D LSCplus
	Double-chamber system 6 kg 4 kg/24 h <–85°C 23 l	Double-chamber system 10 kg 8 kg/24 h <–85°C 50 l	Double-chamber system 12 kg 10 kg/24 h <–78°C 95 l	Double-chamber system 16 kg 10 kg/24 h <–78°C 116 l
	225 x 300 mm –50°C to +60°C <±1 K 1.6 K/min	350 x 400 mm –60°C to +60°C <±1 K 1.3 K/min	350 x 450 mm –60°C to +50°C <±1 K 1.3 K/min	300 x 400 mm –60°C to +50°C <±1 K 1.3 K/min
	860 x 1,374 x 788	1,190 x 1,303 x 968	1,570 x 1,974 x 1,397	1,562 x 1,910 x 847
	330 kg	750 kg	1,200 kg	1,200 kg
	3 x 400 V / 50 Hz 3 x 208 V / 60 Hz 3 x 230 V / 60 Hz	3 x 400 V / 50 Hz 3 x 208 V / 60 Hz 3 x 230 V / 60 Hz	3 x 400 V / 50 Hz 3 x 480 V / 60 Hz	3 x 400 V / 50 Hz 3 x 480 V / 60 Hz
	○	○	●	●
	61 dB(A)	64 dB(A)	80 dB(A)	65 dB(A)
	Hot gas	Hot gas	Hot gas	Hot gas
	● ○ ○	– ● ○	– ● ○	– – –
	● ●	● ●	● ●	● ●
	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○
	● ● ○ ○ ○	● ● ○ ○ ○	● ● ○ – ●	● ● ○ – ●

These specifications apply to the base unit with standard shelf configuration and an ambient temperature range of +10°C to +25°C.

Capacities and shelf dimensions

Epsilon 1-4 LSCplus & Epsilon 2-4 LSCplus

Shelf dimensions (W x D x H): 270 x 400 x 20 mm								
Vial volume (total)			2 ml	6 ml	10 ml	20 ml	50 ml	100 ml
Number of shelves	Area (m²)	Spacing (mm)	Max. number of vials [a)]					
1	0.108	140	430	225	180	120	50	30

Epsilon 2-6D LSCplus

Shelf dimensions (W x D x H): 225 x 300 x 15 mm								
Vial volume (total)			2 ml	6 ml	10 ml	20 ml	50 ml	100 ml
Number of shelves	Area (m²)	Spacing (mm)	Max. number of vials [a)]					
1	0.07	250	280	130	115	72	36	21
2	0.14	117	560	260	230	144	72	42
3	**0.21**	**73**	**840**	**390**	**345**	**216**		
4	0.27	51	For trays, MTP/deep well plates, etc.					
5	0.34	40						
6	0.40	31						

Epsilon 2-10D LSCplus

Shelf dimensions (W x D x H): 350 x 400 x 15 mm								
Vial volume (total)			2 ml	6 ml	10 ml	20 ml	50 ml	100 ml
Number of shelves	Area (m²)	Spacing (mm)	Max. number of vials [a)]					
1	0.14	354	613	326	266	165	83	49
2	0.28	170	1226	652	532	330	166	98
3	0.42	108	1839	978	798	495	249	
4	0.56	77	2452	1304	1064	660		
5	**0.70**	**59**	**3065**	**1630**				
6	0.84	47	For trays, MTP/deep well plates, etc.					
7	0.98	38						

Epsilon 2-12D LSCplus

Shelf dimensions (W x D x H): 350 x 450 x 15 mm								
Vial volume (total)			2 ml	6 ml	10 ml	20 ml	50 ml	100 ml
Number of shelves	Area (m²)	Spacing (mm)	Max. number of vials [a]					
1	0.16	381	688	357	294	189	96	60
2	0.32	183	1376	714	588	378	192	120
3	0.47	117	2064	1071	882	567	288	180
4	**0.63**	**84**	**2752**	**1428**	**1176**	**756**	**383**	
5	0.79	64	3440	1785	1470			
6	0.95	51	4128					

Epsilon 2-16D LSCplus

Shelf dimensions (W x D x H): 300 x 400 x 14.5 mm		
Number of shelves	Area (m²)	Spacing (mm)
1	0.12	963
2	0.24	474
3	0.36	311
4	0.48	230
5	**0.60**	**181**
6	0.72	148
7	0.84	125
8	0.96	107
9	1.08	94
10	1.20	83
11	1.32	74
12	1.44	67

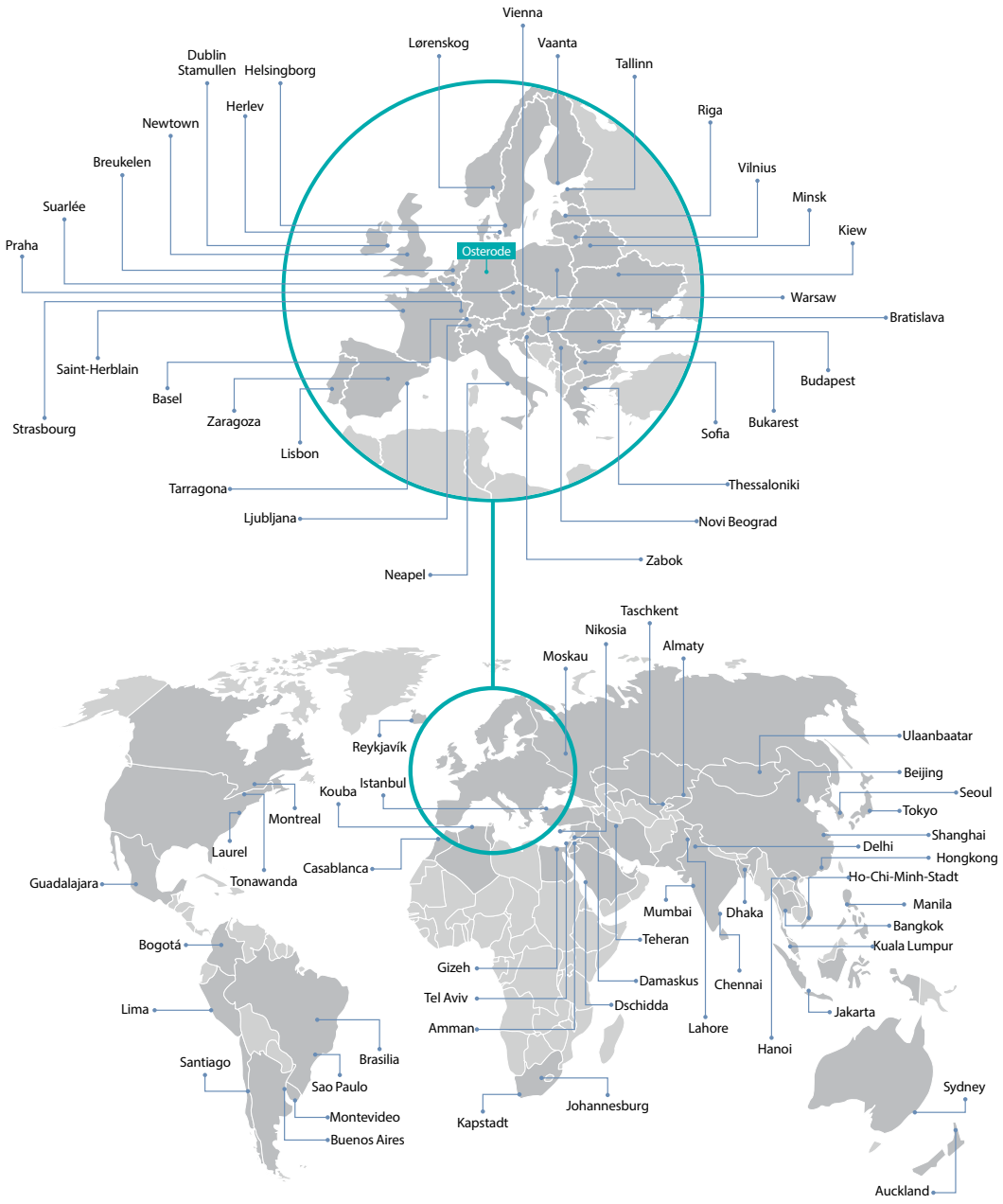
Primarily used with trays and other formats; vials can also be lyophilized but not automatically sealed.

Vial size overview

Total vial volume	2 ml	6 ml	10 ml	20 ml	50 ml	100 ml
Vial type	2R	6R	10R	20R	50H	100H
↕ mm vial only	35	40	45	55	73	95
↕ mm with Lyo plug	45	50	55	65	83	105
⌀ mm	16	22	24	30	43	52
Net fill volume at 1 cm fill height (ml)	1.2	2.2	4.0	4.6	6.0	7.0

Global service for local production reliability

Our systems are operating successfully in over 70 countries around the world. An international network of partners is available for service and qualification tasks. Our specialists can also be engaged quickly around the world, either remotely or on site in person.



Selected locations of our representatives.
An overview of all representatives with detailed contact information can be found at www.martinchrist.de

Our product range

With a unique and broad graduated range of devices and accessories, we can supply freeze drying systems and vacuum concentrators for every application. Let us show what we can do!

1 Freeze drying systems for industrial production with ice condenser capacity from 20 to 500 kg; custom system design including LyoShuttle loading and unloading system.

2 Pilot freeze drying systems for process development and/or optimization with ice condenser capacity from 4 to 16 kg.

3 Freeze drying systems for routine applications or research and development with ice condenser capacity from 2 to 24 kg.

4 Rotational vacuum concentrators for applications ranging from routine to evaporation concentration in the high-end range of pharmaceuti-

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